

CLAIMS

I claim:

1. An automatic drilling system for automatically regulating the release of the drill string of a drilling rig during the drilling of a borehole, comprising:

- a drilling fluid pressure sensor;
- a drilling fluid pressure regulator coupled to said drilling fluid pressure sensor, said drilling fluid pressure regulator measuring changes in drilling fluid pressure and outputting a signal representing those changes;
- a relay coupled to said drilling fluid pressure regulator, said relay responsive to the output signal of said drilling fluid pressure regulator to supply a drill string control signal at an output thereof; and
- a drill string controller coupled to said relay wherein a decrease in drilling fluid pressure results in said relay supplying a drill string control signal that operates said drill string controller to effect an increase in the rate of release of said drill string and an increase in drilling fluid pressure results in said relay supplying a drill string control signal that operates said drill string controller to effect a decrease in the rate of release of said drill string.

2. The automatic drilling system according to claim 1, further comprising:

- a bit weight sensor;
- a bit weight regulator coupled to said bit weight sensor, said bit weight regulator measuring changes in bit weight and outputting a signal representing those changes;
- a relay coupled to said bit weight regulator, said relay responsive to the output signal of said bit weight regulator to supply a drill string control signal at an output thereof; and
- said drill string controller coupled to said relay wherein a decrease in bit weight results in said relay supplying a

drill string control signal that operates said drill string controller to effect an increase in the rate of release of said drill string and an increase in bit weight results in said relay supplying a drill string control signal that operates said drill string controller to effect a decrease in the rate of release of said drill string.

Sub Bb 3. An automatic drilling system for automatically regulating the release of the drill string of a drilling rig during the drilling of a borehole, comprising:

- a drill string torque sensor;
- a drill string torque regulator coupled to said drill string torque sensor, said drill string torque regulator measuring changes in drill string torque and outputting a signal representing those changes;
- a relay coupled to said drill string torque regulator, said relay responsive to the output signal of said drill string torque regulator to supply a drill string control signal at an output thereof; and
- a drill string controller coupled to said relay wherein a decrease in drill string torque results in said relay supplying a drill string control signal that operates said drill string controller to effect an increase in the rate of release of said drill string and an increase in drill string torque results in said relay supplying a drill string control signal that operates said drill string controller to effect a decrease in the rate of release of said drill string.

4. An automatic drilling system for automatically regulating the releasing of the drill string of a drilling rig during the drilling of a borehole, comprising:

- a drill string RPM sensor;
- a drill string RPM regulator coupled to said drill string RPM sensor, said drill string RPM regulator measuring changes in drill string RPM and outputting a signal representing

those changes;

a relay coupled to said drill string RPM regulator, said relay responsive to the output signal of said drill string RPM regulator to supply a drill string control signal at an output thereof; and

a drill string controller coupled to said relay wherein an increase in drill string RPM results in said relay supplying a drill string control signal that operates said drill string controller to effect an increase in the rate of release of said drill string and a decrease in drill string RPM results in said relay supplying a drill string control signal that operates said drill string controller to effect a decrease in the rate of release of said drill string.

5. An automatic drilling system for automatically regulating the releasing of the drill string of a drilling rig during the drilling of a borehole, comprising:

a drilling fluid pressure sensor;

a bit weight sensor;

a drilling fluid pressure regulator responsive to changes in drilling fluid pressure for outputting a signal representative of those changes;

a bit weight regulator responsive to changes in bit weight for outputting a signal representative of those changes;

a first relay connected to said drilling fluid pressure regulator, said first relay responsive to the output signal of said drilling fluid pressure regulator to supply a first drill string control signal at an output thereof;

a second relay connected to said bit weight regulator, said first relay responsive to the output signal of said bit weight regulator to supply a second drill string control signal at an output thereof;

a relay selector connected to said first and second relay to select any one of said first drill string control signal,

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said second drill string control signal, and both of said first and second drill string control signals to control the release of said drill string; and

a drill string controller coupled to said first and second relays wherein when said first drill string control signal represents a decrease in drilling fluid pressure, said drill string controller increases the rate of release of said drill string and when said first drill string control signal represents an increase in drilling fluid pressure, said drill string controller increases the rate of release of said drill string, and further wherein when said second drill string control signal represents a decrease in bit weight, said drill string controller decreases the rate of release of said drill string and when said second drill string control signal represents an increase in bit weight, said drill string controller decreases the rate of release of said drill string.

10. The automatic drilling system according to claim 9, further comprising:

- a drill string torque sensor;
- a drill string RPM sensor;
- a drill string torque regulator responsive to changes in drill string torque for outputting a signal representative of those changes;
- a drill string RPM regulator responsive to changes in drill string RPM for outputting a signal representative of those changes;
- a third relay connected to said drill string torque regulator, said third relay responsive to the output signal of said drill string torque regulator to supply a third drill string control signal at an output thereof;
- a fourth relay connected to said drill string RPM regulator, said fourth relay responsive to the output signal of said drill string RPM regulator to supply a fourth drill

string control signal at an output thereof;

B said relay selector further connected to said third and fourth relays to select any one of said first, second, third, and fourth drill string control signals, a combination of said first, second, third, and fourth drill string control signals, and all of said first, second, third, and fourth drill string control signals to control the release of said drill string; ^{and}

said drill string controller coupled to said third and fourth relays wherein when said third drill string control signal represents a decrease in drill string torque, said drill string controller increases the rate of release of said drill string and when said third drill string control signal represents an increase in drill string torque, said drill string controller decreases the rate of release of said drill string, and further wherein when said fourth drill string control signal represents a increase in drill string RPM, said drill string controller increases the rate of release of said drill string and when said fourth drill string control signal represents a decrease in drill string RPM, said drill string controller decreases the rate of release of said drill string.

11/ 7. A method for automatically regulating the release of the drill string of a drilling rig drill, comprising the steps of:

measuring drilling fluid pressure;

producing a signal in response to changes in drilling fluid pressure, said signal representing the changes in drilling fluid pressure;

B relaying said signal to a drill string controller; ^{and}

controlling said drill string controller to increase the rate of release of said drill string when said signal represents a decrease in drilling fluid pressure and to decrease the rate of release of said drill string when said signal represents an increase in drilling fluid

pressure.

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8. A method for automatically regulating the release of the drill string of a drilling rig drill, comprising the steps of:

measuring drill string torque;
producing a signal in response to changes in drill string torque, said signal representing the changes in drill string torque;
relaying said signal to a drill string controller;
controlling said drill string controller to increase the rate of release of said drill string when said signal represents a decrease in drill string torque and to decrease the rate of release of said drill string when said signal represents an increase in drill string torque.

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9. A method for automatically regulating the release of the drill string of a drilling rig drill, comprising the steps of:

measuring drill string RPM;
producing a signal in response to changes in drill string RPM, said signal representing the changes in drill string RPM;
relaying said signal to a drill string controller;
controlling said drill string controller to increase the rate of release of said drill string when said signal represents a increase in drill string RPM and to decrease the rate of release of said drill string when said signal represents an decrease in drill string RPM.

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10. A method for automatically regulating the release of the drill string of a drilling rig drill, comprising the steps of:

measuring drilling fluid pressure and bit weight;
producing a first signal in response to changes in drilling fluid pressure, said first signal representing the changes in drilling fluid pressure;
producing a second signal in response to changes in bit weight, said second signal representing the changes in bit weight;
selecting any one of said first signal, said second signal,

and both said first and said second signals to control the release of said drill string; and

relaying said selected signal or signals to a drill string controller which regulates the release said drill string in response to said selected signal or signals.

11. The method according to claim 10, further comprising the steps of:

measuring drill string torque and drill string RPM
producing a third signal in response to changes in drill string torque, wherein said third signal represents the changes in drill string torque;

producing a fourth signal in response to changes in drill string RPM, wherein said fourth signal represents the changes in drill string RPM;

selecting any one of said first, second, third, and fourth signals, a combination of said first, second, third, and fourth signals, and all of said first, second, third, and fourth signals to regulate the release of said drill string; and

relaying said selected signal or signals to a drill string controller which regulates the release said drill string in response to said selected signal or signals.

12. A fluid pressure sensor, comprising:

an enclosure having an inlet feeding into a cavity within said enclosure and an outlet feeding out from said cavity;

a first boot covering the inlet into said cavity;

a second boot covering the outlet from said cavity;

a piston positioned within said cavity between said first and second boots wherein fluid pressure against the enclosure inlet side of said first boot pushes said first boot against said piston to force said piston against said second boot and push said second boot against fluid within said enclosure outlet, thereby transferring the fluid pressure to the fluid within said enclosure outlet.

13. A wellhead compensation valve, comprising:

an enclosure having an first inlet, a second inlet, an outlet,
and a cavity which contains a cross-shaped piston;

said first inlet coupled to a fluid pressure sensor to receive
a fluid signal representing drilling fluid pressure and
apply that fluid signal against a first arm of said
piston;

said second inlet coupled to a fluid pressure sensor to
receive a fluid signal representing wellhead pressure and
apply that fluid signal against a second arm of said
piston positioned in opposed relationship to said first
arm of said piston;

a third and fourth arm of said piston positioned in opposed
relationship to exert pressure against fluid within said
cavity in response to the fluid signal exerted against
said first arm of said piston and the fluid signal
exerted against said second arm of said piston to
produce at said enclosure outlet a fluid signal
representing the difference between the drilling fluid
pressure and the wellhead pressure.

14. A hydraulic load cell low fluid level warning system,
comprising:

a first plate connected to the top of a diaphragm of said
hydraulic load cell;

a second plate connected to the bottom of said diaphragm of
said hydraulic load cell;

an air valve having an inlet orifice, a first outlet orifice,
a second outlet orifice, a base positioned on said second
plate, and an arm contacting said first plate;

said inlet orifice receiving compressed air from an air
supply, wherein when the level of the hydraulic fluid
within said diaphragm remains above a safe level, the
compressed air exhausts from said first outlet orifice to
indicate a safe level of hydraulic fluid, and when the
level of the hydraulic fluid within said diaphragm falls
below a safe level, said diaphragm contracts to force

said first and second plates together, resulting in said arm being forced within said air valve to divert the compressed air from said first outlet orifice to said second outlet orifice, thereby indicating an unsafe level of hydraulic fluid within said diaphragm.